Comparison of GPM DPR and Airborne Radar Observations in OLYMPEX

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Overview

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- OLYMPEX in 2015 provided two cases in which GPM was under-flown by the APR3 airborne precipitation radar
- Direct comparison of the DPR and APR3 data provides opportunities to assess effects of resolution on DPR observations and retrievals
- DPR horizontal resolution ~5 km; APR3 horizontal resolution ~1 km
- DPR sensitivity: 12/17 dBZ, APR3 sensitivity 1/-13 dBZ
- Last year's poster on this has been updated with new figures and analyses (with paper accepted in IEEE GRSL)

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- The first DPR under flight case was December 3, 2015 at 15:22 UTC mostly over land.
  - Prefrontal, warm sector of a midlatitude cyclone
  - 17 minutes of APR3 data centered on GPM overpass time
- The second case occurred on December 19 at 02:55 UTC, over ocean and was postfrontal.
  - Small, isolated convective cell during the GPM overpass.
  - Much simpler situation than Dec 3; focus on it first

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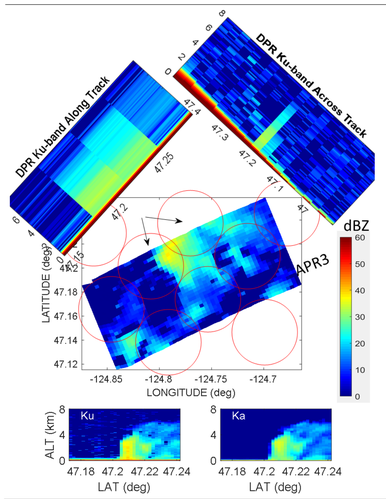

Dec 19 case

Vertical sections and swath views of key measurements. The geolocated DPR footprints (circles) are superimposed on the collocated APR-3 Ku-band Z_m at 1 km above sea level.

Of the two DPR profiles with Z_m > 20 dBZ (arrows), only the left one overlaps with high reflectivity APR3 data.

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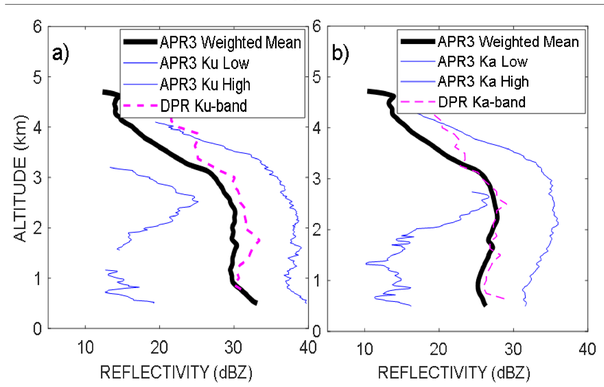

a) Vertical profiles of Ku-band Z_m
b) Vertical profiles of Ka-band Z_m.

The thick black lines are the mean APR3 profiles for each. Also shown are APR3 low and high Z_m profiles.

weighting uses gaussian beam, like DPR

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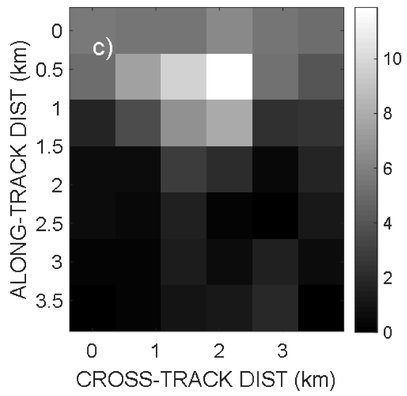

c) horizontal (plan-view) image of the APR3 Ka-band PIA within the DPR footprint. The maximum APR3 Ka-band PIA is 11.7 dB.

The average of the PIA in the linear domain converted back to log domain is 2.1 dB. Average of PIA in dB is 2.8 dB.

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- In above analysis, linear average is SRT estimate of PIA. Log average is the PIA due to the average rain rate.
- Difference is NUBF effect on DPR PIA: reduction of 0.7 dB, based on simulation of DPR with APR3 data.

- DPR Ka-band SRT PIA is 1.4 dB, while "final" PIA is 3.3 dB, closer to difference in Ku-band and Ka-band near-surface reflectivity: 30.7 and 26.4 dBZ
- DPR Solver module solution uses a small number Nw~1000 of large particles, mean size 1.6 mm to best match observed DPR reflectivities and SRT PIA

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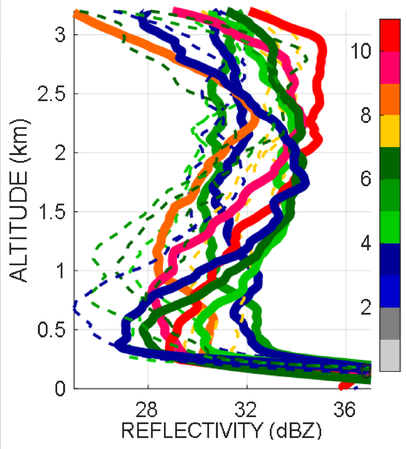

Eighteen Ka-band APR-3 line of sight Z_m profiles within the DPR footprint corresponding to all APR-3 beams with Ka-band PIA > 3dB; color represents PIA, thickness indicates profiles that dominate reflectivity at some altitude or have large PIA

DPR profile shape is more determined by geometry than microphysics

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Peak storm height from both radars is 6 km on Dec 19

The DPR product precipitation type is 18031000

- "18" indicates that the type is stratiform but that the dual-frequency method could not be used.
- The following "0" indicates no bright-band found.
- The "3" and "1" indicate classification as "other", or transitional, based on the vertical profile, and "stratiform", based on the horizontal reflectivity pattern

APR3 Doppler data confirm the presence of an updraft, as would be expected in convection.

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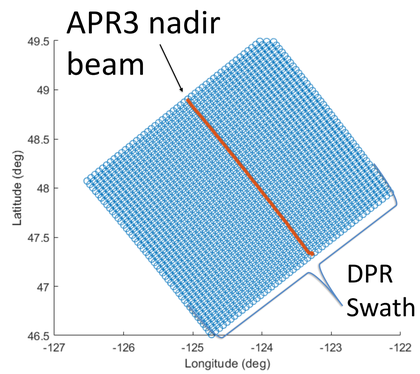
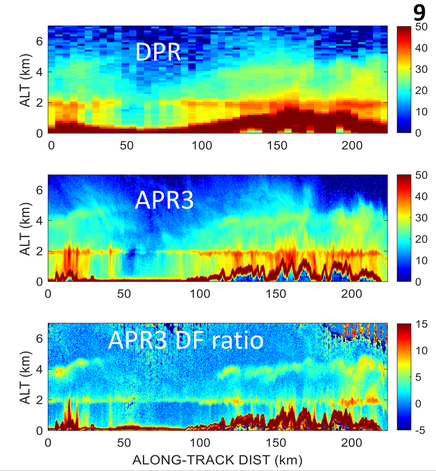
Dec 3 Case





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- A bright-band can be seen at altitude 2 km, both radars.
- The APR3 bright-band is stronger (reflectivity 43 versus 39 dBZ at 125 km) and sharper (0.3 km thickness from APR3 versus 0.6 km from the DPR product).
- The precipitation type in the DPR product is a mix of convective and stratiform, as would be inferred from the APR3 data.
- The DPR near-surface phase is reported as liquid, except in some areas over the Olympic mountains. APR3 data suggest that the surface precipitation is liquid.
- At 10 km, peak Ku-band Zm is 49 dBZ (APR3) and 38 dBZ (DPR)
- DPR detects heavy ice near along-track distance 200 km. APR3 has large DF ratio in this area.

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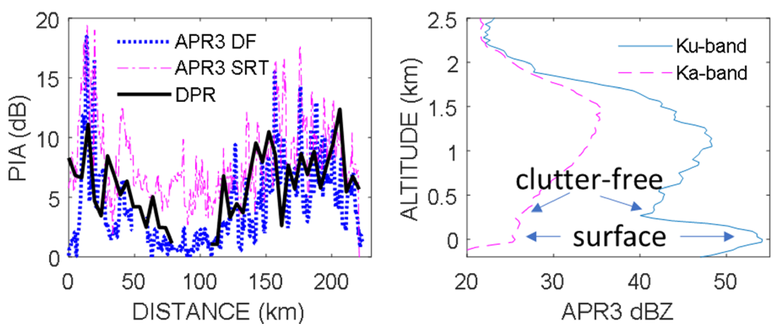

Left: DPR Ka-band PIA, with two estimates of PIA from APR3 data. Missing DPR data near 100 km due to low reliability. At right are APR3 Z_m profiles for the large DF PIA at 10 km in the left panel.

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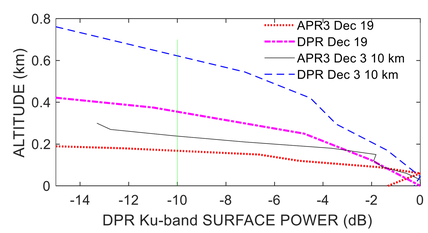

APR3 and DPR Ku-band surface profiles for Dec 3 (10 km along-track distance) and Dec 19. Altitude is relative to the peak of the surface return (adjusted to 0 dB in all cases). The vertical line at -10 dB allows comparison of the distance from the surface. DPR clutter over topography relatively worse than for APR3.

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